1/31/01

EPA review of emergency response plan

Conf Call w/ Elizabeth & Julie
re Elk Hills UIC permit

UIC permit cannot inc conds that are not designed to protect USDWs
&
(i.e., nothing unrelated to protection of USDWs

Puna Geothermal (600' buffer around each well for protection of health & envt +
∴ we cannot inc terms & conds of B.O. in UIC permit for Elk Hills

lots of case law that says EPA's jurisdiction does NOT extend beyond protection of USDWs (here, TBC in B.O. relate to protection of endangered species)

→ EAB: EPA must show how these conds related to USDWs or remove these conds from the UIC permit (Elizabeth ∴ removed
at end of opinion

"no suff nexus to USDWs"
no statutory authority
(EAB would not look to reg)

2 options:
we could: ① ask for letter from Elk Hills revising its project description to say "we commit to follow TBC in B.O. in implementing UIC permit"

② do nothing

*Pam Schultz has copy of letter addressed

→ PSD division (re air permit)
→ at least get a copy & put it in VIC
admin record

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August 21, 2000

George Robin
U.S. Environmental Protection Agency, Region IX
Ground Water Office, WTR-9
75 Hawthorne Street
San Francisco, CA 94105-3901

Re: Draft UIC Permit for Elk Hills Power, LLC

Dear Mr. Robin:

We are writing on behalf of the California Unions for Reliable Energy ("CURE") to comment on EPA's proposal to issue an Underground Injection Control ("UIC") permit to Elk Hills Power, LLC ("Elk Hills" or "the Applicant") for two Class I injection wells in the Elk Hills Oil Field. CURE is an association of labor unions whose members build, operate and maintain commercial, residential and industrial projects. CURE's members live in and use the areas that suffer the impacts of environmentally detrimental projects, and are concerned that continued environmental degradation may jeopardize future jobs by making it more difficult and more expensive for business and industry to locate and expand in California and by making it less desirable for people to live here.

EPA's proposal fails to meet the requirements of the Safe Drinking Water Act[1] and its implementing regulations for several reasons. First, EPA has not complied with the requirements of the Endangered Species Act[2] or the National Historic Preservation Act,[3] which it must do prior to approving the proposed permit for Elk Hills. Second, EPA's proposal does not prevent the movement of fluid containing harmful contaminants into underground sources of drinking water, as it

[1] 42 U.S.C. §§ 300f *et seq.*
[2] 16 U.S.C. §§ 1531 *et seq.*
[3] 16 U.S.C. §§ 470 *et seq.*

must. Third, EPA's proposal fails to satisfy numerous additional requirements of the UIC program.

We reviewed EPA's proposal with the technical assistance of Dr. Phyllis Fox and geologists from William Lettis and Associates. Dr. Fox has both MS and Ph.D. degrees in environmental engineering from the University of California at Berkeley and 30 years of experience in groundwater permitting and analyses for hundreds of industrial facilities, including other power plants. Dr. Fox's comments on the Project and a copy of her qualifications are attached as Exhibit 1. Jeffrey Bachhuber from William Lettis and Associates has both MS and BA degrees in geology from San Jose State University. He is also a registered geologist and a certified engineering geologist in the State of California, and has over 15 years of experience performing geologic studies for numerous industrial facilities, including power plants. The comments of William Lettis and Associates and Mr. Bachhuber's qualifications are attached as Exhibit 2. We identify legal concerns with the proposed permit and summarize the technical concerns of these experts below.

I. EPA'S PROPOSAL DOES NOT COMPLY WITH THE ENDANGERED SPECIES ACT OR ITS OWN REGULATIONS

EPA's proposal would allow Elk Hills to drill and operate two Class I injection wells for the disposal of cooling tower blowdown and other wastewater from a proposed 500 MW power plant that would be located approximately four miles away. Construction and operation of the proposed injection wells, the pipeline leading to the wells, and the power plant would disrupt habitat for and may harm or take a number of species that have been listed as threatened and endangered under the federal Endangered Species Act. These species include San Joaquin kit fox, giant kangaroo rat, San Joaquin antelope squirrel, Swainson's hawk, and blunt-nosed leopard lizard.[4] Because EPA's approval of Elk Hills' application for a UIC permit may affect these and other listed species, EPA must comply with the requirements of section 7 of the Endangered Species Act before taking any further action on the application.

Section 7 of the Endangered Species Act ("ESA")[5] requires all federal agencies to fulfill a number of substantive and procedural requirements before

does EPA need to undertake consultation prior to issuing UIC permit if EPA already consulted for "Elk Hills Power Project" which includes associated facilities? has EPA consulted w/ USFWS pursuant to draft BA??

[4] A comprehensive identification of the listed plants and animals at the Project site is attached as Exhibit 3. (Draft Biological Assessment for Elk Hills Power Project, p. 2 (December, 1999).)
[5] 16 U.S.C. § 1536.

taking any action that may adversely affect listed species. First, agencies must utilize their authorities to conserve threatened and endangered species.[6] Second, agencies must consult with the U.S. Fish & Wildlife Service to insure that any action authorized by the agency is not likely to jeopardize the continued existence of any endangered or threatened species.[7] Third, agencies must utilize the best scientific and commercial data available to assess their impacts on endangered species.[8] Fourth, after initiation of section 7 consultation, neither the federal agency nor the permit applicant may make any irreversible or irretrievable commitment of resources with respect to the agency action which has the effect of foreclosing the formulation or implementation of any reasonable and prudent alternatives.[9]

EPA's UIC regulations explicitly require the agency to comply with section 7 of the Endangered Species Act. The regulations recognize that:

> [w]hen [the ESA] is applicable, its procedures must be followed. When the applicable law requires consideration or adoption of particular permit conditions or requires the denial of a permit, those requirements also must be followed. (40 C.F.R. § 144.4.)

The Environmental Appeals Board has confirmed that EPA has a duty under the UIC regulations to determine whether threatened and endangered species would be impacted by the agency's actions and to comply with the requirements of the ESA.[10]

EPA has failed to comply with the requirements of the ESA here, even though it is clear that those requirements apply. Elk Hills' own draft biological assessment ("Draft BA") acknowledges that EPA's action may affect listed species. The Draft BA anticipates that construction of the 4.4-mile wastewater discharge pipeline and proposed injection wells would disturb 8.63 acres of listed species' habitat. (Exhibit 3, Draft BA, p. 24.) The Draft BA also acknowledges that constructing and operating the Project may result in the incidental take of individuals or populations of federally listed species. (Ex. 3, Draft BA, p. 25.) The Draft BA recommends that a series of measures be implemented to mitigate the Project's impacts on listed species, none of which are incorporated in EPA's

draft BA is for construction of Elk Hills Power Project, which is a power plant and associated linear facilities

[6] *Id.* at § 1536(a)(1).
[7] *Id.* at § 1536(a)(2).
[8] *Ibid.*
[9] *Id.* at § 1536(d).
[10] *In the Matter of Renkiewicz SWD-18*, UIC Appeal No. 91-4, at 65 (June 24, 1992).

proposed UIC permit. More importantly, USFWS has not yet had an opportunity to review EPA's proposed action and to recommend its own mitigation measures for the protection of listed species. Thus, EPA's permit does not comply with the requirements of section 7.

EPA's approval of Elk Hills' application for a UIC permit is a federal action that may affect listed species. Therefore, EPA must comply with all applicable requirements of the ESA before taking any further action on Elk Hills' UIC application. Those requirements include initiating formal consultation with the U.S. Fish & Wildlife Service over the potential impacts of the Project, and prohibiting any irreversible or irretrievable commitment of resources until consultation is complete.

II. EPA'S APPROVAL DOES NOT COMPLY WITH THE NATIONAL HISTORIC PRESERVATION ACT OR ITS OWN REGULATIONS

EPA's UIC regulations also require that EPA comply with the National Historic Preservation Act ("NHPA") before issuing a UIC permit. (40 C.F.R. § 144.4.) The regulations explain that:

> Section 106 of the [NHPA] and implementing regulations (36 CFR part 800) require the Regional Administrator, before issuing a license, to adopt measures when feasible to mitigate potential adverse effects of the licensed activity and [sic] properties listed or eligible for listing in the National Register of Historic Places. The Act's requirements are to be implemented in cooperation with State Historic Preservation Officers and upon notice to, and when appropriate, in consultation with the Advisory Council on Historic Preservation. (40 C.F.R. § 144.4(b).)

EPA has failed to comply with these requirements here.

EPA's proposal to issue a UIC permit to Elk Hills is an "undertaking" as that term is defined under the NHPA (*see* 36 C.F.R. § 800.16(y)) that has the potential to cause effects on historic properties. The injection wells, wastewater discharge lines and power plant proposed by Elk Hills lie in an archaeologically rich area. Cultural resource staff at the California Energy Commission, who are also reviewing the proposed project, have identified 81 known cultural resources in the area which would be affected by the power plant and its associated facilities, and 24 cultural

resources within the Area of Potential Effect around these facilities. (Exhibit 4,[11] Dominguez Testimony, p. 6.) The proposed injection wells alone lie along the historic shoreline of Buena Vista lake, which was home to at least one Yokuts village and would have constituted a favorable environment for other, earlier settlements. Native American tribes in the vicinity consider all cultural resources at the Elk Hills Oilfield significant. (Ex. 4, Dominguez Testimony, p. 7.) Although the Applicant has conducted preliminary surface surveys to identify additional archaeologically and culturally significant sites, Energy Commission staff acknowledge that "it is very difficult to recognize the presence, size, or importance of archaeological remains from surface observations" and that "regardless of what has been identified, there is always a possibility of encountering subsurface cultural resources." (Exhibit 4, Dominguez Testimony, p. 7.)

The NHPA requires EPA to identify and protect these types of archeologically significant sites prior to issuing Elk Hills a UIC permit. (*See* 36 C.F.R. §§ 800.4-800.6.) However, neither EPA's proposed permit nor the accompanying administrative record indicate that EPA has taken any of the required steps here. EPA cannot approve Elk Hills' application until it satisfies the applicable requirements of the NHPA.

III. EPA'S APPROVAL DOES NOT COMPLY WITH OTHER STATUTORY AND REGULATORY REQUIREMENTS

EPA's proposed permit fails to comply with numerous other statutory and regulatory requirements, as explained more fully in the attached analyses of Dr. Fox and William Lettis and Associates ("WLA").

Most significantly, the proposed permit fails to meet the primary requirement of the UIC program: the prohibition on harmful contaminants entering underground sources of drinking water ("USDWs"). (42 U.S.C. §§ 300h-1(c), 300h(b); 40 C.F.R. § 144.12(a).) The Applicant bears the burden of demonstrating that this requirement is met. (40 C.F.R. § 144.12(a).) It has failed to do so here.

The attached letter from WLA raises three concerns indicating that the proposed wells may cause harmful contaminants to enter underground sources of

[11] Testimony of Delia (Dee) Dominguez on Behalf of the California Unions for Reliable Energy on Cultural Resource Impacts of the Elk Hills Power Project (Jan. 12, 2000) (without exhibits).

drinking water.[12] First, WLA has identified the likely presence of potentially active faults near the proposed injection wells and crossing the pipeline supply route. The faults have not been adequately characterized and could lead to rupture of supply pipelines and proposed wells, injection-induced seismicity, near-field coseismic fault rupture, and lateral migration of injected waste along fault fractures or permeability contract interfaces. Any of these conditions could allow Project wastewater to move between the exempt portion of the Tulare aquifer and nearby USDWs.[13]

Second, WLA's analysis establishes the questionable nature of the Tulare Clay that the Applicant and EPA rely on to act as a confining layer between the receiving aquifer and USDWs. The existing evidence indicates that this confining layer is much more permeable than the Applicant and EPA assume in their calculations underlying the proposed permit conditions. Although EPA requests additional information about the confining layer in the draft permit (Permit, Condition C.3), this information would be submitted too late for EPA to assure that the proposed wells will be constructed and operated to prevent the movement of fluids into or between USDWs, as it must. (*See, e.g.*, 40 C.F.R. §§ 144.12(a), 146.12-146.14.) In addition, by requiring submission of this crucial information after the close of the public comment period, EPA has deprived interested parties of their right to review and comment upon some of the most critical elements of the proposal. (*See generally* 40 C.F.R. § 124.)

Proce-dural objections

Third, WLA demonstrates that the radius of well influence, even when calculated according to the Applicant's methods, overlaps alluvial aquifers in Buena Vista Valley and may introduce harmful contaminants into USDWs.

Dr. Fox concurs that the proposed permit does not prohibit the movement of contaminated wastewaters into underground sources of drinking water. Dr. Fox focuses on impacts to the USDW portion of the Tulare Formation, which is a non-exempt aquifer outside of the boundaries of the Elk Hills Oilfield, and on alluvial aquifers. Dr. Fox corrects numerous errors in the Applicant's calculation of the proposed wells' area of review and establishes that injectate would migrate into these USDWs. She also notes that the proposed wells could be sited even closer to

[12] WLA's concerns demonstrate that EPA's proposal fails to comply with other regulatory requirements as well, including 40 C.F.R. §§ 146.7, 146.12, 146.13, and 146.14.

[13] We have previously submitted information regarding a potential fault near the site of the proposed injection wells to EPA. (Letter from Lizanne Reynolds to Martin Zeleznick w/attachments (Nov. 23, 1999).) We have resubmitted that information here as Exhibit 5.

the USDW portion of the Tulare aquifer because the location of the wells is not adequately defined in the draft permit. Dr. Fox further establishes that the predicted concentration of arsenic in the injected wastewaters would exceed EPA's proposed drinking water standard for arsenic. Thus, the migration of these fluids into USDWs would cause or contribute to exceedances of proposed drinking water standards and pose health risks.

Dr. Fox raises numerous additional violations of EPA's UIC regulations in the permit review process and the permit itself. These include the failure to: (1) adequately characterize USDWs within the area of review before the permit is issued; (2) adequately characterize the injection fluids before the permit is issued; (3) require adequate monitoring plans before the permit is issued; and (4) require corrective action for wells within the area of review. All of these steps must be taken *before* the permit is issued by EPA, but have not been. (*See* 40 C.F.R. § 146.14(a).) Further, the UIC regulations require that, prior to granting approval for operation of Class I wells, the Director shall consider the "compatibility of injected waste with fluids in the injection zone and minerals in both the injection zone and the confining zone." (40 C.F.R. § 146.14(b)(6).) Dr. Fox explains that incompatibility between the injectate and receiving groundwater is likely in this case. However, there is no evidence that EPA has adequately considered this issue or taken steps to prevent it.

We appreciate the opportunity to comment on EPA's proposed action. Please contact us if you have any questions about these matters.

Sincerely,

Katherine S. Poole

KSP:bh
Attachments

1152a-208

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J. PHYLLIS FOX, Ph.D.
ENVIRONMENTAL MANAGEMENT

August 21, 2000

Katherine S. Poole
Adams Broadwell Joseph & Cardozo
651Gateway Boulevard, Suite 900
South San Francisco, CA 94080

Dear Ms. Poole:

As you requested, I have reviewed the draft Underground Injection Control ("UIC") Class I nonhazardous Permit No. CA200002 ("Permit") issued by U.S. EPA, Region IX. Two injection wells would be used to dispose of up to 15,000 barrels per day of wastewater generated by the Elk Hills Power Project ("Project"). I also reviewed supporting agency files, including the Application,[1] correspondence between the Applicant and EPA, and other materials submitted electronically.[2]

These materials indicate that the draft Permit is premature. Several items that should be submitted before the Permit is issued are missing, including identification and delineation of underground sources of drinking water ("USDWs"), complete injectate analysis, an injectate monitoring plan, a corrective action plan, and a contingency plan. The permit does not require a compatability analysis, which must be reviewed by EPA before injection commences. Finally, the Applicant underestimated the area of review, which is at least 1.2 miles, not 0.5 miles as claimed by the Applicant. Injected wastewater would migrate outside of the exempt portions of the Tulare Formation, into nonexempt USDWs south of the Elk Hills Oilfield where they would cause or contribute to exceedances of primary drinking water standards.

My detailed comments are attached.

Very truly yours,

J. Phyllis Fox By BK

J. Phyllis Fox, Ph.D.

[1] San Joaquin Energy Consultants, Inc., Information Needs for Class V Injection Wells, Elk Hills Power Project, September 21, 1999.
[2] E-mail from George Robin, U.S. EPA, to Rich Texier, Adams Broadwell Joseph & Cardozo, August 14, 2000.

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THE UIC PERMIT IS PREMATURE

Prelim. Disposal Objections

The UIC regulations require that certain technical information be submitted to the Director and considered *prior* to the issuance of a permit for the construction of a new Class I well. (40 CFR 146.14(a).) Some of this required information is not present in the Application or EPA file on this project and thus has not been considered. Once the well is permitted and constructed, certain additional information must be submitted and considered prior to granting approval to operate the well. (40 CFR 146.14(b).) Some of this information or permit conditions requiring the production of some of this information are also missing. Therefore, the UIC permit is both premature and inadequate. The missing information should be obtained from the Applicant and the permit appropriately revised and recirculated for public review.

Underground Sources Of Drinking Water

The EPA concluded that "data indicates the possibility of an Underground Source of Drinking Water (USDW) occurring in this area. It is most likely to exist within the upper, unconfined aquifer above the Tulare clay in undifferentiated alluvium." (Application, Statement of Basis, p. 2.) We agree, and note that several ephemeral stream channels are present near the proposed wells which may reasonably be expected to support fresh alluvial aquifers.[1] Further, the proposed wells are close to the southern boundary of the Elk Hills Oilfield. The Tulare Formation where the wastes would be injected is exempt within the boundaries of the Oilfield, but not outside of those boundaries. (Application, Attach. 26.)

The regulations require that the Applicant submit "maps and cross sections indicating the general vertical and lateral limits of all underground sources of drinking water within the area of review, their position relative to the injection formation and the direction of water movement, where known, in each underground source of drinking water which may be affected by the proposed injection" *before* the permit to construct is issued. (40 CFR 146.14(a)(4).) The Application and project file contain none of this information. Instead, the draft permit contains a condition requiring the Applicant to collect some portion of the required information during construction of the new wells and prior to commencing injection. (Permit, Condition C.1.a, p. 9.) This condition is not adequate for three reasons.

[1] USGS, Taft, California 7-1/2 Minute Quad, Photorevised 1973, T31S, R24E, Section 18.

First, the regulations explicitly require that the information that would be collected during well construction, after permit issuance, be submitted and reviewed by the Director *before* the permit is issued. Thus, EPA is proposing to issue a permit that allows collection of data which the regulations demand be in the Application.

Second, EPA proposes to require different well construction requirements based on this post-permitting data. (Permit, Condition C.1.a.i.) Adequate well construction is essential to assure that USDWs are protected. This condition would allow modification of a very important permit condition, well design, after the close of public comment, precluding public review and violating the public review requirements at 40 CFR part 124. To avoid this violation, EPA should withdraw the draft permit and reissue it only after the Applicant collects and submits the data required by the regulations. Only through recirculation after that necessary data is collected may interested parties, as well as EPA, be assured that all USDWs will be protected by the proposed permit conditions.

Third, the condition, even if it were allowed by the regulations (which it is not), is vague as to the nature of the data that would be collected. At a minimum, the Applicant should be required to collect sufficient lithology, water level, TDS and other water quality data to map the vertical and lateral limits of USDWs within the area of review. Given the heterogeneity in the area documented in the Application, we believe this would require a minimum of seven separate 600-ft deep wells, four located at quarter points around a circle with a radius equal to the radius of review, two located between the radius of review and proposed injection wells, and one located between the two proposed injection wells. At least three of these wells should be located within the alluvial material along the ephemeral drainages within the area of review. This information should be used to revise the permit, which should then be recirculated for public review.

Injectate Analysis

The UIC regulations require that "an analysis of the chemical, physical, radiological and biological characteristics of injection fluids" be submitted and considered by the Director before the permit is issued. (40 CFR 146.14(a)(7)(iii).) The injectate characterization data in Attachment 20 of the Application (Water Balance at Peak Load) only includes major cations and anions such as calcium, magnesium, chloride, and sulfate. Trace elements and biological characteristics are not reported. Trace element composition data is essential to evaluate potential impacts on local USDWs (because the power plant's source water contains trace elements) and to assess compatibility of the

injectate with formation fluids, as discussed below. Further, cooling tower blowdown may contain algae and other biological growth that could clog injection wells and the formation outside of the well.

For example, the source water for the power plant contains 4.8 ug/L of arsenic. (Application, Attach 20, West Kern Water District.) This water would be concentrated six times in the cooling tower and the blowdown would thus contain 29 ug/L of arsenic. (Application, p. 13.) This exceeds the recently proposed revision to the arsenic drinking water standard of 5 ug/L.[2] The existing Tulare formation water contains 4.7 to 19.5 ug/L of arsenic. (Application, Attach. 13.) Therefore, the injection would degrade the quality of the receiving formation. Moreover, as explained below, nothing in the proposed permit prevents injection waters from migrating into the non-exempt USDW portion of the Tulare Formation immediately south of the Elk Hills Oilfield boundary. Thus, the permit also fails to protect USDWs from violations of a proposed drinking water standard when the waste front reaches that point.

Finally, it is impossible to assess the extent of potential contamination of USDWs because the Application presents only a portion of the information that the regulations require. The Applicant argues that no actual analyses are available because operations have not commenced. (Application, p. 14.) However, it is feasible to present engineering calculations of the chemical composition of the injectate. These calculations should include constituents for which primary drinking water standards have been established and which are likely to be present. The calculations should include all chemicals that are added during water use, such as biocides, corrosion inhibitors, oxygen scavengers, and chemical used to control condensate/feedwater pH and other characteristics.[3] These chemicals could cause further drinking water violations if added to the injection waters in sufficient amounts.

Monitoring Plan

The UIC regulations require that "plans (including maps) for meeting the monitoring requirements in § 146.13(b)" be submitted and considered by the Director before the permit is issued. (40 CFR 146.14(a)(13).) These monitoring requirements include "analysis of the injected fluids with sufficient frequency to yield representative data of their characteristics." (40 CFR 146.13(b)(1).) The subject monitoring

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[2] National Primary Drinking Water Regulations; Arsenic and Clarifications to Compliance and New Source Contaminants Monitoring, Federal Register, v. 65, no. 121, June 22, 2000, p. 38888 *et seq.*

[3] See, for example, Brad Buecker, Fundamentals of Steam Generation Chemistry, PennWell, Tulsa, OK, 2000 and the Application for Certification, Elk Hills Power Project, February 1999, Table 5.12-1.

plans were not provided in the Application or any other materials in the project file that I reviewed.

The Application indicates that the only monitoring that is proposed is mechanical integrity. (Application, p. 24.) Elsewhere, the Application asserts that a sampling plan with QA/QC procedures for injectate "will be developed." (Application, p. 14.) The project file contains no evidence that this plan was ever developed. Moreover, the permit only contains a requirement that one initial sample of the injectate's chemical composition be taken. (Permit, Condition C.1.(e).) This requirement is not of "sufficient frequency to yield representative data of [the injectate's] characteristics" (40 CFR § 146.13(b)(1)) which includes, at minimum, quarterly reports on the chemical characteristics of the injectate. (40 CFR 146.13(c)(1)(i).)

The project file and draft permit neither contain nor require any of this information. The lack of monitoring requirements is problematic because of the possibility that the injectate could impact USDWs and because the permit generally requires that injected wastes be nonhazardous (Permit, Condition C.6.a) but provides no method of demonstrating compliance with this condition after initial startup. This would allow the Applicant to inject hazardous or otherwise harmful wastes without being discovered.

The Applicant should be required to submit a monitoring plan to periodically characterize the injectate. To comply with UIC regulations, this plan should specify the sampling location, monitoring frequency, parameters, and methods that would be used. (40 CFR 144.43(b).) At a minimum, injectate samples should be analyzed at least quarterly immediately prior to the wellhead using EPA test methods for all of parameters listed in 40 CFR 261 that may be present. The permit should be revised to incorporate the monitoring plan and recirculated for public review.

Corrective Action Plan

The UIC regulations require a corrective action plan for any wells within the area of review which penetrate the injection zone, but which are not properly completed or plugged. (40 CFR 146.14(a)(14).) The EPA concluded that "no corrective action is needed for wells located within the Area of Review," but did not provide the basis for this statement. (Statement of Basis, p. 3.) The project file suggests that this conclusion is incorrect.

The Application identified two abandoned wells within the area of review. (Application, Attach. 1.) One was a shallow well with a total

depth of 250 feet (U.S. Navy No. 1-18G). This well likely did not penetrate the injection zone, which is 565 to 618 feet below ground surface. (Application, p. 9.)

However, the second abandoned well, U.S. Navy No. 2-18G, is 1,860 feet deep and located 950 feet from one of the proposed injection wells.[4] (Application, pp. 3-4.) Based on cross section B-B', this well does penetrate the injection zone. (Application, Attach. 8.) The well was abandoned in 1934 by filling the hole from 535 feet below ground surface ("bgs") to the ground surface with dirt and capping it with one sack of cement. The condition of the hole below 535 feet bgs is unknown, but apparently contained stovepipe casing which could not be removed. Water was present in this well at 245 feet bgs at the time that it was abandoned. (Application, Attach. 2.)

The procedures that were used to cap this well, backfilling with sand, are not adequate to prevent migration of fluids between penetrated aquifers, in violation of UIC regulations. The dirt fill would allow water and injectate from the injection zone to migrate through the dirt fill into any overlying alluvial aquifers, which may be USDWs. Wells are properly abandoned when they are filled with concrete, which prevents fluid migration in the borehole. (See, for example, 40 CFR 146.10.)

Further, this improperly abandoned well is within the area of influence of the proposed injection wells. According to calculations in Attachment 18 of the Application, the injected waste front would reach a point about 950 feet from the injection well after 18 years of operation. After 30 years of operation, the life of the proposed power plant that the wells would serve, the waste front would extend a minimum of 1,203 feet from the injection well, easily reaching and encompassing well 2-18G. Therefore, one can reasonably anticipate that this improperly abandoned well could provide a migration pathway for injected wastes to reach any overlying USDWs.

The UIC regulations require that for wells that are "improperly sealed, completed, or abandoned, the applicant shall also submit a plan consisting of such steps or modifications as are necessary to prevent movement of fluid into underground sources of drinking water ("corrective action")." 40 CFR 144.55(a). Therefore, the Applicant should be required to submit a corrective action plan to properly

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[4] We note that the base map in Attachment 1 of the Application shows that this well is about 1,300 feet from proposed injection well 35 while the text at page 4 claims this well is 1,950 feet from proposed injection well 35 and only 950 feet from proposed injection well 15. There are similar discrepancies between other existing wells reported on page 4 of the Application and the base map.

abandon well 2-18G. The permit should be revised to reflect the plan and recirculated for public review.

Fluid Compatibility

The UIC regulations require that, prior to granting approval for operation of Class I wells, the Director shall consider the "compatibility of injected waste with fluids in the injection zone and minerals in both the injection zone and the confining zone." 40 CFR 40 146.14(b)(6). Compatibility is important because injectate may react with the formation or its natural fluids to form precipitates that can clog the formation in the vicinity of the well bore. Wastewater treatment may be required prior to injection to prevent unacceptable pressure buildup from formation and well clogging. Further, precipitates would reduce the porosity of the formation, which would increase the rate of movement of the waste front, increasing the zone of influence of the wells.

The Application asserts, with no support whatsoever, that "incompatibility of injectate and receiving groundwater is not anticipated." (Application, p. 14.) The EPA's statement of basis is silent on this issue. However, chemical characterization data presented in the Application suggests that this assertion is not correct.

The injectate is mostly cooling tower blowdown (*ibid.*), which is rejected from the tower because it has reached the limit of saturation of compounds that may precipitate out in the cooling tower. Concentrations of calcium, sulfate, bicarbonate and silica in the blowdown, for example, are near the limits of saturation. (Application, Attach. 20.) The injectate, which is 80 to 85 degrees F when it leaves the cooling tower, will cool when it is injected and mixes with formation water. Calcium, magnesium, and other alkaline earth metals which are present in the injectate and/or the formation water can react with carbonates, sulfate, phosphates, fluorides, silicates, and other anions in the injectate and formation, forming additional precipitates. (Application, Attachs. 13, 20.) This will cause precipitation of alkaline earth metals calcium, magnesium, barium and strontium as relatively insoluble carbonates, sulfates, hydroxides, orthophosphates, or fluorides. Further, metals such as iron, zinc, chromium and cadmium can precipitate as insoluble sulfides, hydroxides, carbonates, or orthophosphates. These precipitates will deposit in the formation around the well, reducing permeability and increasing injection pressure.[5]

[5] Texas Department of Water Resources, Underground Injection Control Technical Assistance Manual, NTIS Report PB85-176477, April 1983, page 16.

Plugging by bacterial action is also a common problem. Bacterial growth can be promoted by a change in temperature caused by injection warmer cooling tower blowdown to a cooler aquifer. Therefore, the bacterial characteristics of the injectate and a mixture of injectate and Tulare Formation water should be evaluated in a compatibility test. (Driscoll 1986, p. 772. [6])

In light of this information, the unsupported assertion offered by the Applicant is not an adequate compatibility analysis. (Application, p. 14.) Moreover, the permit itself is silent on this issue and does not contain a condition requiring a compatibility analysis. Therefore, the permit should be modified to specifically require a compatibility analysis so that the compatibility determination required by 40 CFR 146.14(b)(6) can be made. The condition should be in sufficient detail to assure that the effects of changes in temperature of the saturated waste stream as well as chemical reactions between the injectate and formation fluids and reservoir formation and biological plugging are properly tested.

USDWs WOULD BE ADVERSELY AFFECTED

The UIC regulations prohibit "the movement of fluid containing any contaminant into underground sources of drinking water, if the presence of that contaminant may cause a violation of any primary drinking water regulation under 40 CFR part 142 or may otherwise adversely affect the health of persons." The burden is on the applicant to demonstrate that this requirement is met. (40 CFR 144.12.) The Applicant has not met this burden, as discussed below.

There are at least two potential USDWs in the vicinity of the proposed injection wells. First, as discussed above, there may be overlying alluvial aquifers, particularly along ephemeral stream channels in the area. The Applicant has not provided the information necessary to determine the location and vertical and lateral extent of these aquifers. Second, the Tulare Formation itself is a USDW outside of the boundary of the Elk Hills Oilfield. The Tulare Formation within the boundary of the Elk Hills Oilfield is exempt as a source of drinking water. (Application, p. 21.) However, this exemption does not extend outside of the boundary. (Application, Attach. 26.) The proposed wells are in the southern portion of the Oilfield, only about one-half mile from the southern-most boundary of the Oilfield based on the Area of Review and Area of Influence Map included in Attachment 1 of the Application.

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[6] Fletcher G. Driscoll, Groundwater and Wells, 2nd Ed., Johnson Division, St. Paul, Minn, 1986.

The Tulare Formation, outside of the boundaries of the Oilfield, meets the definition of a USDW, which include those aquifers that contain sufficient water to supply a public water system and contain less than 10,000 mg/L of total dissolved solids ("TDS"). (40 CFR 144.3.) The Application indicates that the TDS of water in the Tulare Formation ranges from 4,485 mg/L to 6,142 mg/L, less than 10,000 mg/L. (Application, p. 10 and Attachs. 13-14.) The Application also indicates that the Tulare Formation is currently providing source water for oil production activities (Application, p. 3), typically producing 80 gpm/ft. (Application, Attach. 2, well 45WS-18G.) Thus, a typical well with a 100-foot screened interval could produce 8000 gpm. In Kern County, where the Project is located, the per capita water use is about 375 gallons per day per capita.[7] Therefore, a single well could provide water to 30,720 individuals. This is enough to support a public water supply. Therefore, the Tulare Formation beyond the exempted portion within the Elk Hills Oilfield is a USDW.

As discussed above, the concentration of arsenic in the raw supply water for the Elk Hills power plant is high enough to exceed or contribute to exceedances of the currently proposed drinking water standard on arsenic. Therefore, if injectate migrates outside of the boundary of the Elk Hills Oilfield, a proposed primary drinking water standard would be exceeded and the health of any person drinking the water would be adversely affected. This is prohibited under the UIC program.

The Applicant underestimated the radius of influence of the proposed injection wells. As discussed below, two factors make it likely that injectate will migrate into non-exempt aquifers.

Area Of Review

To assure compliance with the prohibition on movement of fluid into underground sources of drinking water, the UIC regulations require that certain information be provided and considered within the "area of review" prior to issuing a permit and granting permission for operation of the injection well. (40 CFR 146.14.) The Applicant did not properly calculate the area of review of the wells. When the errors in the Applicant's calculation are corrected, the resulting radius of influence encroaches on non-exempt aquifers that qualify as USDWs.

The Applicant selected as the area of review the greater of a 0.5-mile radius around each injector or the "area of influence" calculated to

[7] California Department of Water Resources (DWR), Urban Water Use in California, Bulletin No. 166-2, October, 1975, Table 2 and DWR, Municipal and Industrial Water Use, Bulletin No. 166-1, August 1968, Table 10.

be 994 feet. (Application, pp. 2, 15 and Attachs. 1 and 18.) The Applicant did not provide any authority or support for this approach. There are several problems with this approach.

First, the Applicant provided no support for the selected fixed radius of 0.5 miles, which is too low for a Class I well. Based on an EPA survey, other states and regions routinely use larger fixed radii for Class I wells, typically from 1 to 2-1/2 miles. For example, in Region V, Minnesota uses 2 miles and Illinois uses 2.5 miles. In Region VI, Louisiana uses 2 miles, New Mexico 2.5 miles, and Texas 2.5 miles. In Region VII, Kansas uses 1 mile. (Platt 3/17/98.[8])

Second, the Applicant calculated an "area of influence," which it equates to the "zone of endangering influence" defined at 40 CFR 146.6, but it did not follow the requirements prescribed in 40 CFR § 146.6. That section requires that the area of review be determined in one of two prescribed manners. First, the area of review or "zone of endangering influence" may be determined using the modified Theis equation shown in the regulations or a comparable method. (40 CFR § 146.6(a)(2).) Second, the area of review may be determined by establishing a fixed radius around the well, but *only* "[i]n the case of application(s) for well permit(s) under § 122.38." (40 CFR § 146.6(b).) The Application here is not for a well permit under § 122.38, which has not been promulgated. Therefore, the first method of calculating the area of review based on a mathematical model comparable to the modified Theis equation must be used.

The Applicant did not use a model comparable to the Theis equation for calculating this parameter. The Applicant also did not use the inputs required under the regulations. When these problems are corrected, the "area of influence" is demonstrated to extend outside of the exempted aquifer, into a USDW.

First, the Applicants' calculations are for 20 years while the life of the power plant that the wells would support is 30 years. The regulations state that the computation "should be calculated for an injection time period equal to the expected life of the injection well or pattern." (40 CFR § 146.6(a)(2).) The Applicant anticipates that these wells would last for the life of the proposed power plant, or 30 years. (3/9/00 RT 140:6-22.)[9] The Applicant has not proposed any other

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[8] S. Stephen Platt, EPA Region 3, A Underground Injection Control Summary of Regional and State Implementation of the Area of Review, March 17, 1998. (Available on EPA website.)

[9] Transcript of Evidentiary Hearing before the California Energy Resources Conservation and Development Commission, Elk Hills Power Project, Docket No. 99-AFC-1, March 9, 2000. Available on CEC website at www.energy.ca.gov.

method for disposing of the plant's wastewater, which it would have had to disclose and analyze under the California Energy Commission's licensing requirements if any other disposal method was anticipated. Therefore, both EPA and the Applicant must base the area of review computation on a 30-year project life.

Second, the Applicant included contaminant dispersion in its calculations, but assumed a dispersion coefficient of only 3 feet for sandstone. Sandstones typically have a porosity of about 1% to 5%, while the subject formation is reported to have a porosity of 34%. Therefore, the assumed dispersion coefficient would underestimate the radius of influence. A higher dispersion coefficient should have been used.

Third, the equation that the Applicant used only estimates the *minimum* radial extent of spread of a wastewater and therefore is not conservative.[10] The source relied on by the Applicant states "A good estimate of the minimum distance of wastewater flow from an injection well can be made by assuming that the wastewater will uniformly occupy an expanding cylinder with the well at the center." The discussion continues, pointing out that "In most situations the minimum radial distance of travel will be exceeded, because of dispersion, density segregation, and channeling through high permeability zones. Flow may also be in a preferred direction, rather than radial, because of hydrologic discontinuities (e.g., faults), selectively oriented permeability paths, or natural flow gradients." (Warner and Lehr 1981,[11] p. 109,underlining in original.)

Fourth, the equation used by the Applicant is overly simplified, ignoring the properties of the receiving aquifer. The Tulare Formation is a confined aquifer. Injected materials travel much greater distances in confined aquifers.

Finally, this method is apparently not widely accepted as it was not reported as a method used by any of the regions that responded to EPA's survey on methods used to calculate the area of review. (Platt 3/17/98.)

Therefore, we calculated the area of review using the Theis equation from 40 CFR 146.6, modified to account for the fact that the Tulare Formation is a confined aquifer and to evaluate a UDWS

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[10] D.L. Warner, Monitoring of Class I Injection Wells, In: John A. Apps and Chin-Fu Tsang (Eds.) Deep Injection Disposal of Hazardous and Industrial Waste. Scientific and Engineering Aspects, Academic Press, 1996, pp. 425-526.

[11] Don L. Warner and Jay H. Lehr, Subsurface Wastewater Injection. The Technology of Injecting Wastewater into Deep Wells for Disposal, Premier Press, Berkeley, CA, 1981.

downgradient and in the same aquifer as the injection zone. The modified Theis equation for this case is (Driscoll 1986, p. 771):

$$Q = Kb(h_w - H_o)/528 \log(r_o/r_w) \quad (1)$$

where

Q = injection rate in gpm = 438 gpm = 84,218 f^3/day (App., p. 23.)
K = hydraulic conductivity = 99.65 gpd/ft^2 =13.3 ft/day (App., p. 9)
b = aquifer thickness from top of Amnicola clay to bottom of Tulare clay = 1200 ft (Attach. 8, Sec. A-A')
h_w = head above the bottom of aquifer while recharging =1433 ft (Eq. 2)
H_o = head above bottom of aquifer when no pumping is taking place = 1425 ft (Attach. 8, Sec. A-A')
r_o = radius of influence in feet
r_w = radius of injection well in feet = 0.36 ft (App., p. 17.)

The head above the bottom of the aquifer while recharging was calculated from the following equation (Baumann 1965,[12] p. 239):

$$h_w = -a_o + (a_o^2 - Q/\delta K[\ln(r_w/L) + 0.72])^{1/2} \quad (2)$$

where

a_o = initial depth of groundwater, from water table to top of Amnicola clay = 1,425 ft (Attach. 8, Sec. A-A').
$L = (10TKa_o)/i)^{1/2}$ = 78,127 ft
i = porosity = 0.34 (App., p. 8.)
T = injection time = 10,950 days (30 yrs)

Substituting these values into Equation (2) yields the head above the bottom of the aquifer while recharging, h_w, which is 1,433 feet. Therefore, injection would create a mount of wastewater in the vicinity of the injection well that is 8 feet above the original elevation of the water table or 1433 ft - 1425 ft = 8 ft. Solving Equation (1) for r_o, yields the radius of influence of 4,980 ft without considering dispersion. Dispersion may be accounted for using the Applicant's procedure (Warner and Lehr 1981, p. 112):

$$r_o' = r_o + 2.3(Dr_o)^{1/2} \quad (3)$$

where

[12] Paul Baumann, Technical Development in Ground Water Recharge, Advances in Hydroscience, v. 2, 1965.

D = dispersion coefficient = 65 ft (Warner and Lehr 1981, p. 112)
r_o' = radial distance of travel with dispersion.

Solving Equation (3) yields a radius of influence of 6,289 feet.

Thus, using the procedure recommended in 40 CFR 146.6 (a)(2), which accounts for local aquifer properties, yields a radius of influence (or "zone of endangering influence") that is substantially higher than the 950 feet to 0.5 miles assumed by the Applicant. This has three important consequences.

First, the injected wastewater would move beyond the boundary of the Elk Hills Oilfield, into nonexempt UDWSs south of the Oilfield. The southern extent of the wastewater plume would encompass the floodplain of Buena Vista Creek, which likely supports an alluvial aquifer that may be a UDWS.

Second, the zone of influence is large enough to encompass a large number currently active oil production wells. (Application, Attach. 1.) These wells could serve as conduits that would allow injected wastewater to penetrate UDWSs.

Finally, the Application only reviewed information within the radius of review, which was selected as 0.5 miles. This analysis demonstrates that the area of review should have been at least 1.2 miles. This substantially expands the scope of the investigation that must be presented to support the UIC Application. For example, Attachment 1 shows that there are a number of additional abandoned wells within the 1.2 mile radius that were not included in the well review in Attachment 2. Therefore, the Applicant should be requested to update its Application to address this larger area of review.

Studies conducted in this area and cited by the Applicant suggest that injected wastewater from currently operating, nearby injection wells is currently moving out of the injection zone and adversely affecting local water quality. Benzene, which occurs at elevated concentrations in the currently injected produced water, has been found in the source wells within Section 18G. This study recommended that "a monitoring well be completed in the southeast corner of Section 18 G [where the proposed injection wells would be located] to determine if wastewater and the constituents associated with the wastewater are being sufficiently retarded in the exempt portions of the Tulare Formation and not migrating towards adjacent non-exempt areas located to the southeast in

Section 20G." (Bechtel 2/95,[13] p. 7-5.) It does not appear that the recommended well has been installed based on information provided by the Applicant in Attachments 1 and 2. Therefore, and in light of the foregoing, we recommend that EPA require one or more monitoring wells to evaluate whether injectate moves outside of the exempt aquifer.

Location of Wells

The draft permit reports the location of the wells in "Section 18, T.31 S., R.24 E, in Kern County, California." (Permit, p. 4.) Notwithstanding the above, this is not an adequate description to assure that injectate remains within the exempt portion of the aquifer. Given this description, these wells could be located anywhere within Section 18. If they were located near the southern boundary of the section, for example, the zone of influence, irrespective of the method used to determine the area of review, would extend into nonexempt portions of the aquifer. Therefore, the draft permit should be reviewed to specify the latitude and longitude of the proposed wells, as is customary.[14]

[13] Bechtel, NPR-1 Ground Water Protection Management Program, April 1994, Revised February 1995.

[14] See, for example, UIC Permit No. HI596002, issued to Puna Geothermal Venture.

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Investigations have been completed for a wide range of facilities and activities including redevelopment projects (e.g., Mission Bay, Southern Pacific Railyards, Moscone Center Expansion, San Diego Padres Ballpark), reformulated fuels projects, refineries, petroleum distribution terminals, oil production fields, underground storage tanks, gasoline stations, landfills, railyards, hazardous waste treatment facilities, hazardous waste sites, remediation of contaminated sites, oil shale plants, asphalt plants, incinerators, flares, cogeneration plants, power plants, airports, hydrocrackers, hydrogen plants, tank farms, a wide range of manufacturing plants including for semiconductors, electronic assembly, aerospace components, printed circuit boards and amusement park rides, lanthanide processing plants, ammonia plants, urea plants, food processing plants, grain processing facilities, paint formulation plants, wastewater treatment plants, sulfur recovery plants, enhanced oil recovery operations, commercial and residential developments, marine terminals, gas processing plants, steel mills, battery manufacturing plants, pesticide manufacturing and repackaging facilities, and a wide range of mines including sand and gravel, limestone, nacholite, coal, gold, zinc and oil shale, among others.

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Directed and participated in research on environmental impacts of energy development in the Colorado River Basin, including contamination of surface and subsurface waters.

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Performed engineering and modelling studies on surface and ground water contamination, air pollution, thermal pollution, eutrophication, industrial waste treatment, and solid waste disposal for a variety of domestic and international projects. Played a major role in Northern California water resource planning studies. Prepared portions of the Basin Plans for the Sacramento, San Joaquin, and Delta basins including sections on water supply, water quality, and agricultural drainage. Coordinated a high-level task force established to investigate corrosion/erosion-type failures of nuclear power plants. Developed and applied numerical models of water treatment processes, groundwater systems, estuaries, and river systems. Developed several large-scale data management systems for environmental monitoring data.

PROFESSIONAL SOCIETIES

Society of Environmental Toxicology and Chemistry

Association for the Environmental Health of Soils

American Chemical Society

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MISCELLANEOUS

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Member, National Research Council Committee on Irrigation-Induced Water Quality Problems (Selenium), Subcommittee on Quality Control/Quality Assurance (1985-1990)

Member, National Research Council Committee on Surface Mining and Reclamation, Subcommittee on Oil Shale (1978-80)

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August 18, 2000

RE: Geologic Review of Draft Permit CA 200002 for Class 1 Nonhazardous Waste Injection, Disposal Wells 15-18G and 35-18G, Elk Hills Power Plant

Dear Ms. Poole:

This letter presents the results from the William Lettis & Associates, Inc. additional review of geologic issues pertaining to the proposed Elk Hills Power Plant (EHPP) pipeline and disposal wells, located on the former NPR-1 on the south flank of the Elk Hills, north of Taft, California. Our previous letter of November 16, 1999 presented our initial comments based on review of the project Application for Certification (AFC) and various supporting documents and reports. Since submittal of the November 16, 1999 review letter, we have performed further review of the project including: (1) a one-day field review of the proposed disposal site in February, 2000; (2) review of Draft Permit No. CA200002 for Class 1 Nonhazardous Waste Injection Wells 15-18G and 35-18G; (3) review of testimony statements from consultants working on behalf of the Applicant (Ms. D. Thompson; Mr. B. Hanson); (4) review of a supplemental geologic report by Mr. T. Gutcher of Smith-Gutcher Associates, Inc.(February 25, 2000) prepared to respond to faulting issues raised in our November 16, 1999 review letter; and, (5) re-examination of aerial photographs, site visit photos and notes, and information in our project file.

1.0 Unmitigated Potentially Significant Geologic Issues

This letter focuses on three specific geologic issues that we believe have not yet been adequately resolved by existing studies or the draft permit provisions, and pose potentially significant safety or environmental impacts: (1) the presence of potentially active faults along the southern flank of the Elk Hills located about 1,200 to 2,100 feet north of the proposed injection wells and crossing the proposed supply pipeline route; (2) the variable and inadequately characterized geologic properties of the Tulare Clay that bring into question it's ability to act as a positive barrier to wastewater migration; and (3) the radius of well influence that overlaps alluvial aquifers in Buena Vista Valley and presents possible negative effects on alluvial aquifers.

We believe that each of these issues requires further evaluation and additional documentation to show that they do not pose significant risk and can be properly mitigated. Permit conditions presented in the Draft Permit CA200002 do not adequately address or mitigate the specific three geologic issues. It is our opinion that the following additional studies or monitoring measures should be performed prior to issuance of the final permit, and/or included in the final permit conditions.

1.1 Fault Hazard. Based on our additional review, we believe that the presence of potentially active faults along the south flank of the Elk Hills at the project site is strongly suggested by geologic and geomorphic conditions. The study performed by Smith-Gutcher Associates, Inc. (February 25, 2000) did not provide sufficient documentation of the absence of faulting to confidently dismiss the presence of, and possible hazards related to, these possible faults. Subsurface exploration and fault evaluation by shallow trenching should be performed across the two closest possible fault strands shown on Figure 1 of the November 16, 1999 WLA report north of the proposed well sites. These trenches could be readily excavated into the Tulare Formation bedrock and across the possible fault traces. Trench exposures should be examined by an independent third party reviewer, and should be carefully logged and photographed. If exploratory trenches do not show evidence of shallow faulting, then potential fault issues could be dismissed. However, if faults are encountered in the trenches, additional mitigation will be required to address: (1) possible fault rupture of the supply pipeline (that crosses the possible fault traces) and disposal wells; (2) potential for injection-induced seismicity; (3) near-field earthquake ground shaking from coseismic fault rupture; and, (4) possible lateral migration of injected waste along fault fractures or permeability contrast interfaces.

1.2 Tulare Clay Properties. The existing and current well analyses and design is based on extrapolation of information from other wells located hundreds or thousands of feet away, and existing regional geologic and hydrogeologic data. No site-specific exploration or testing has been performed at the proposed well locations. Our field examination of Tulare Formation outcrops nearest to the proposed well site, directly updip from the wells, shows that the "Tulare Clay" is actually composed primarily of sand and gravel, with clayey interbeds. Comparison of existing well data with outcrop exposures indicates that the composition of the Tulare Formation changes significantly both laterally and vertically, and is not a homogenous or continuous layer of thick clay. The heterogeneity of the clay content within the Tulare Formation makes extrapolation of data from other wells tenuous. A pre-construction exploratory boring at the proposed disposal well site would confirm the integrity and physical properties of the Tulare Formation, and is recommended prior to issuance of the final well permit. The portion of the boring through the Tulare "Clay" confining zone should be continuously logged by an experienced geologist, and used to perform intermittent packer testing of Tulare Formation permeability. Samples should be obtained at a maximum interval of 15 feet through the proposed upper confining zone for laboratory index testing. Index testing including sieve analyses, Atterberg Indices, and moisture-density testing, should be performed on recovered samples to verify the physical properties and adequacy of the Tulare Formation to serve as an effective barrier to waste migration, and to develop final well design and operation parameters. Alternatively, in lieu of a pre-permit exploratory boring, continuous logging, packer testing, and sampling and index testing of the well boring through the upper Tulare "Clay" confining zone could be included as a condition in the final permit. However, postponement of this work until well drilling presents a risk of well redesign or abandonment if suitable conditions are not encountered at a late stage in the project where such changes will present difficulties.

1.3 Well Radius. A 20-year well influence radius of 994 feet was used for evaluation and design of disposal wells 15-18G and 35-18G (Testimony Cross Examination of B. Hanson, 2000). We note that the stated design life of the project is 30 years, or ten years (150%) longer than used for the influence radius modeling. Mr. Hanson indicated that he recently recalculated the 30-year radius of influence to be 1204 feet. The stated predicted well influence radii extends to, or near, the zone of possible faults shown on the WLA November 16, 1999 review letter Figure 1, and substantially beneath the alluvium of Buena Vista valley. We note that the well influence radius calculations assume that the upper Tulare Clay is an intact layer of clay, rather than consisting primarily of sand such as was observed in outcrop of the confining zone materials directly updip from the well site. Well influence radii for predominantly sand and gravel sediments such as observed in outcrop of the confining zone would likely be significantly greater than estimates presented by the Applicant. The existing well influence radius calculations indicate that the proposed well injection operations could pose a potentially significant contamination hazard to the Buena Vista alluvial aquifer if leakage occurs through the Tulare Formation, or accelerated migration occurs along possible faults in the Tulare Formation. The final injection well permit conditions should include construction and periodic sampling of a monitoring well perforated in the alluvial aquifer downgradient from the injection wells to monitor the condition of the alluvial groundwater and to verify that contaminant migration or breaching has not occurred through the upper Tulare Clay confining zone throughout the well operation period.

Additional discussion regarding these three geologic issues is provided in the following text.

2.0 Possible faults along south flank of Elk Hills

2.3 Reevaluation of WLA-Mapped Lineaments and Possible Faults.

Our previous stereo aerial photograph analyses (William Lettis & Associates, Inc. (WLA), November 16, 1999) identified several lineaments and alignments of truncated or juxtaposed geomorphic features on the south flank of the Elk Hills structure that are strongly suggestive of potentially active faults. These features are continuous over about 3 miles, and possibly as much as 5 miles, trending roughly east-west along the base of the Elk Hills anticline. The WLA lineaments include relatively straight and curvilinear breaks-in-slope, depressions, tonal contrasts, vegetation contrasts, apparently truncated Tulare Formation bedrock beds and ridges, deflected or "captured" drainages, and displaced or juxtaposed ridge spurs. The possible faults typically trend subparallel to Tulare Formation bedding, but in some places cut across or truncate prominent bedrock beds or spur ridges, or occur along changes in strike of bedrock beds. Some reaches of the lineaments are nearly coincident with, or subparallel to, various cultural features such as roads and pipelines, but are clearly distinct from cultural features along most of their trend. We interpret these lineations and alignments of geomorphic features to be possible faults cutting through the Tulare Formation bedrock, and in places through more-recent alluvial sediments. In places the possible faults appear to include bedding plane slip and/or displacement along bedding strike. In other locations, these features appear to be steeply-dipping faults with components of strike slip, oblique, and normal/reverse movement. Faulting in the Tulare Formation likely is associated with active tectonic deformation of the Elk Hills that has formed a series of anticlines and synclines, and other previously-mapped active and Quaternary faults along the Elk Hills (e.g., Woodring et. al., 1932; Jennings, 1994). The California Division of Mines and Geology Fault Activity Map of California

(Jennings, 1994) shows four northeast-trending Quaternary faults on the northeast flank of the Elk Hills that project towards the possible faults that we mapped along the south margin of the hills.

We performed limited field evaluation of portions of the possible faults north of the disposal wells site during a February site visit in company with representatives from the Applicant and their consultants, and members of the CPUC. Our field evaluation confirmed that portions of the possible faults near the disposal well site include geomorphic features suggestive of Quaternary faulting, and are not cultural features. We observed a series of north-south trending drainages and associated ridges near the base of the south flank of the Elk Hills that appear to be offset in a lateral sense, causing juxtaposition of ridges and drainage swales, and deflection or realignment of drainage channels. The offsets line up in a linear fashion along the east-west lineations that we observed on aerial photos. A total of four drainages were observed to have visible offset in the area of our site visit, with offset magnitudes of up to about 50 feet. The lineations occur along an alignment of swales, breaks-in-slope, and similar apparently displaced or deformed ridge crests that extend for a considerable distance east and west of the disposal well site at the location of our mapped photo lineations. We note that cultural features or disruption from roads, pipelines, or other typical linear facilities common in petroleum developments do not cause juxtaposition or deflection of bedrock ridges and drainage swales such as were observed along the possible faults north of the disposal well field.

Deformed and offset ridges and drainages along linear trends is a compelling geomorphic argument supporting the presence of a recently active fault in this location. For example, along the San Andreas fault in the Carrizo Plain, approximately 25 miles west of the Elk Hills site, offset stream channels, drainages, and ridges form some of the classic geomorphic indicators of active fault slip. During the February field visit we discussed some of the geomorphic evidence that supports the presence of faults along the south flank of the Elk Hills. The Applicant's geological representatives, Ms. Donna Thompson and Mr. Thomas Gutcher, stated that no surficial evidence of faulting such as fault breccia or sheared rock was observed along the possible faults during previous investigations. This is not unusual, and geomorphic features often are the only visible evidence for faulting along even well-defined segments of very active faults such as the San Andreas fault in California, and North Anatolian fault in Turkey. Unconsolidated surficial soil typically masks the presence of sheared fault rock, and typically do not develop significant fault gouge due to the lack of confining pressure. For example, at the San Andreas Wallace Creek site, active creek channels and drainages are offset right laterally by over 400 feet, yet the surface trace of the fault typically is obscured by soil and is not indicated by fault breccia or visible soil shearing.

2.2 Smith-Gutcher and Associates Fault Report Review

The results from a supplemental fault evaluation performed by Mr. Thomas Gutcher of Smith-Gutcher and Associates, Inc. (SGA) is presented in a SGA report dated February 25, 2000. The SGA study was performed to respond to fault issues raised in the WLA November 16, 1999 review letter, and included the following scope of work: (1) review of geologic maps and reports; (2) stereographic evaluation of aerial photographs; and, (3) two days of field reconnaissance mapping. Mr. Gutcher listed various reports and maps that he reviewed, and stated that "The reports by Milliken (1992) and Bachhuber and Brankman (1999) were studied in detail because they are the most relevant to the issue of possible surface faults in the vicinity of the project site". We note that his report does not include reference to the official State of California Division of Mines and Geology fault activity map of California (Jennings, 1994, Geologic Data Map No. 6) that shows four Quaternary faults on the northeast flank of the Elk Hills. On the basis of his review of existing geologic

maps and reports Mr. Gutcher stated "My review of the geologic data revealed no evidence, either direct or indirect, that supports the existence of the possible faults mapped by Bachhuber and Brankman (1999) except for the observations in the WLA report". The SGA report also discusses Mr. Gutcher's stereographic analyses of aerial photographs and field reconnaissance. In his report, the various WLA-mapped possible fault traces or segments are referenced as "Possible Fault Segments 1 through 9", and are discussed individually. Mr. Gutcher concluded that "I do not believe there is any significant evidence of active surface faults in the vicinity of the project site...It appears that most of the possible fault segments were mapped along bedding contacts and cultural features".

After reviewing the SGA report, we performed stereographic re-analyses of aerial photographs, review of field notes and photographs made during our February site visit, and review of geologic maps and reports in our project file and office. On the basis of our additional review, we conclude that the lineaments that we mapped on Figure 1 of our November 16, 1999 review letter are strongly suggestive of Quaternary-active faults, and are not bedding contacts or cultural features. As previously discussed, the photolineaments typically are subparallel to Tulare Formation bedding, and may locally represent bedding plane slip and faulting. In other locations, however, the photolineaments obliquely cross and/or truncate bedrock beds and ridges, and in places occurs along visible changes in bedding strike. Additionally, the lineaments are marked by displaced or deflected ridges and drainages that are not caused by cultural features or disruption. The WLA-mapped lineaments/possible faults are clearly distinct from the various cultural features, such as pipelines and roads, mentioned in the SGA report. Cultural features were identified as such during the previous WLA air photo review and February, 2000 site visit, and were not the basis for our interpretation of possible faults. The presence of apparently displaced bedrock ridges and deflected drainages, and lack of cultural disruption, was confirmed during the February field visit along portions of the WLA-mapped possible south flank faults north of the disposal well site.

2.3 Conclusions and Recommendations Regarding Possible Faults.

It is our opinion that the February 25, 2000 SGA report does not provide sufficient documentation to confidently refute the presence of potentially active faults that we believe are strongly suggested by stereographic analyses of aerial photographs and our field review. Additional work including subsurface exploration is necessary and warranted to definitively address the possibility of faults along the south flank of the hills. A series of test pits or trenches, excavated into bedrock by a backhoe or excavator along the lineaments that we have shown on our map, would quickly and definitively establish the presence or absence of an active fault along the south flank of the Elk Hills, and should be performed prior to project construction. Trench exposures should be examined by an independent third party reviewer, and should be carefully logged and photographed. If exploratory trenches do not show evidence of shallow faulting, then potential fault issues could be dismissed. However, if faults are encountered in the trenches, additional mitigation will be required to address: (1) possible fault rupture of the supply pipeline (that crosses the possible fault traces) and disposal wells; (2) potential for injection-induced seismicity; (3) near-field earthquake ground shaking from coseismic fault rupture; and, (4) possible lateral migration of injected waste along fault fractures or permeability contrast interfaces.

Definitive evidence refuting the presence of faults near the site of the proposed injection wells is necessary because of the possible environmental consequences related to pipeline or well rupture from fault movement, potential for triggered slip or creep, and possible influences on injected waste migration. Surface fault displacement could shear the supply pipeline that would cross the fault between the power plant and well site, posing a possible hazard of surface discharge of wastewater. Surface discharge from a pipeline break likely

would flow downhill into the alluvium of Buena Vista Valley. The draft permit does not include provisions to mitigate possible pipeline rupture from surface fault rupture. The close proximity of the well field to the possible faults presents a potential hazard of triggered slip due to changes in stress and fluid migration along faults within the area of well influence. Such movements could possibly result in pipeline or well casing shear or damage, either to the proposed project, or possibly to other nearby wells sited along the trend of the possible faults. Pipeline or well shear or damage also poses a potential contamination hazard to the Buena Vista alluvial aquifer that currently is not addressed in the draft permit. Wastewater fluid migration along the WLA-mapped possible faults could result in unpredictable flowpaths and well influence radius and geometry, and is not addressed in the draft permit.

3.0 Geologic character of Upper Tulare Clay confining unit

Our February visit allowed us to directly examine outcrops of the Tulare clay on the hill flank in the vicinity of the disposal well site. The exposures occur updip of the strata at the well site, and represent the section of the Tulare Clay unit planned to act as the upper confining layer for the proposed wastewater injection zone. These outcrops were located within Section 18 just north of the abandoned tank farm, about 1,000 to 2,500 feet north of the proposed disposal wells site. The examined outcrops are within the area mapped by Milliken (1992), who differentiated the roughly 190-foot thick unit into three clay beds and two intervening sandy gravel beds (69% sand/gravel, 31% clay). Our observations of outcrops within the clay units from the Upper Tulare Clay, specifically the tc_1 (upper clay) bed, show that it is not a solid clay unit, but rather a bed of fine-to medium-grained sand with some clay and gravel beds. Our estimate of clay percentages, based solely on field examination and texturing, is between 10-20%. We did not observe a bed of "hard, silty" clay, as the tc_1 unit is described by Milliken (1992).

Field observations of this unit call into question its ability to act as a confining layer over the zone of injection. The AFC documents describe this unit as a thick, impermeable clay layer, while the outcrops we examined indicate that it is much more permeable than was suggested, with subordinate clayey beds separated by dominant sandy beds. During the field visit, Ms. Donna Thompson suggested that the Upper Tulare Clay is much more clay-rich at depth in the proposed zone of injection. We note, however, that this interpretation is based on interpretive geophysical well logs from wells hundreds to thousands of feet away. Site-specific subsurface exploration, in situ testing, or laboratory index testing on cores from the confining zone or zones have not been performed, and are important to verify the integrity and physical properties of the Upper Tulare Clay as a positive barrier to wastewater migration. At least one pre-construction exploratory boring should be advanced through the Tulare Clay at the proposed disposal well site to verify the integrity and physical properties of the clay unit. The boring should be continuously logged by a geologist, and sampled at 10- to 15-foot intervals. Physical index tests (sieve and hydrometer analyses, Atterberg Limits, moisture-density) should be performed on collected samples to quantify material properties. Alternatively, in lieu of a pre-permit exploratory boring, continuous logging, packer testing, and sampling and index testing of the well boring through the upper Tulare "Clay" confining zone could be included as a condition in the final permit. However, postponement of this work until well drilling presents a risk of well redesign or abandonment if suitable conditions are not encountered at a late stage in the project where such changes will present difficulties.

The draft permit does not discuss specific requirements for further studies to verify the integrity of the Tulare Clay or assumed physical properties. The permit conditions therefore do not provide sufficient measures to protect alluvium overlying the injection zone

from contaminant migration. Existing well design and permit conditions assume that the Tulare Clay will act as a positive, laterally and vertically continuous barrier to wastewater migration. These assumptions may not be valid if the Tulare "Clay" at the well site consists primarily of permeable sand and gravel such as was observed in exposed outcrops along the updip projection of the confinement zone north of the well site. Additionally, possible faulting and fracturing of the Tulare Clay layer could result in unpredictable or accelerated wastewater migration along, or through, the assumed upper confinement zone.

Site-specific verification of the Tulare Clay integrity and physical properties is important to ensures proper assessment of possible environmental impacts and to design the well system. Postponement of this work until well drilling presents a risk of well redesign or abandonment if suitable conditions are not encountered at a late stage in the project where such changes will present difficulties.

4.0 Well Radius

A 20-year well influence radius of 994 feet was used for evaluation and design of disposal wells 15-18G and 35-18G (Testimony Cross Examination of B. Hanson). We note that the stated design life of the project is 30 years, or ten years (150%) longer than used for the influence radius modeling. Mr. Hanson indicated that the 30-year radius of influence would be 1204 feet. The 30-year radius extends to near the zone of possible faults shown on the WLA November 16, 1999 review letter Figure 1, and extends substantially beneath the alluvium of Buena Vista valley. Well radius calculations were based on assumptions that the upper Tulare Clay layer is a continuous strata of intact clay. Well influence radii could be significantly greater than calculatedif the Tulare Clay unit actually consists predominantly of sand and gravel, such as was observed in surface exposures of the confining section north of the well site.

The existing calculated well influence radius indicates that the proposed well injection operations could pose a potentially significant contamination hazard to the Buena Vista alluvial aquifer if leakage occurs through the Tulare Formation, or accelerated migration occurs along possible faults in the Tulare Formation. The final injection well permit conditions should include construction and periodic sampling of a monitoring well perforated in the alluvial aquifer downgradient from the injection wells to monitor the condition of the alluvial groundwater and to verify that contaminant migration or breaching has not occurred through the upper Tulare Clay confining zone throughout the well operation period.

5.0 Closure

We appreciate the opportunity to provide continued geologic review of the Elk Hills Power Plant project. Please feel free to call us at (925) 256-6070 if you have any questions regarding this report.

Sincerely,

WILLIAM LETTIS & ASSOCIATES, INC.

Jeff Bachhuber, R.G. 4909, C.E.G. 1534
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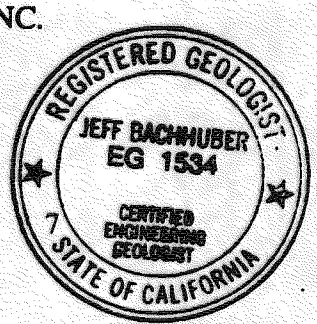

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REPRESENTATIVE EXPERIENCE

Mr. Bachhuber is a Certified Engineering Geologist in California with 15 years of professional experience performing projects throughout the United States, Puerto Rico, Korea, Indonesia, Japan, and Peru. He has performed numerous engineering geologic studies for new and existing facilities including powerplants, dams and tunnels; dam foundation and safety evaluations; tunnel evaluation/retrofit studies; seismic retrofit investigations for highway bridges; landslide and slope stability investigations (soil and rock slopes); penstock geologic/geotechnical evaluations; gas and water supply pipeline hazard assessments; instrumentation studies for concrete arch and rockfill dams; and field reviews for major gas projects. Mr. Bachhuber is specialized in the fields of rock mass mass characterization and stabilization, evaluation of earthquake site response and ground motions, slope stability, construction planning and monitoring, and geotechnical instrumentation. Mr. Bachhuber has completed hundreds of field work assignments, including extended field work from remote field camps in diverse geologic settings such as active coastlines in California and Korea; volcanic terrain in tropical rainforests in Indonesia (central Java); sedimentary basins in the Peruvian Amazon highlands; karst and sedimentary terrain in Puerto Rico; and rugged mountainous and alpine terrain in the California Sierra Nevada.

Mr. Bachhuber is experienced in a wide variety of field data collection methods including detailed geologic mapping, aerial photograph analysis, subsurface exploration with borings and trenches, geophysical refraction and downhole surveys, borehole packer testing, evaluation of construction excavations and foundations, tunnel mapping, and installation and interpretation of geotechnical. He has applied sophisticated analysis methods to assess slope stability, exposure risk, liquefaction potential, and rockfall hazard. Mr. Bachhuber has used state-of-art investigation and analyses techniques to study earthquake response and develop design ground motions for critical facilities including dry cask high level nuclear waste storage, soil-structure interaction of complex pile supported bridges, concrete arch dams, and slope deformation analyses for levees and embankments.

AFFILIATIONS AND PROFESSIONAL DEVELOPMENT

Member, Association of Engineering Geologists
Member, American Rock Mechanics Association
ASCE 1999 Rickey Medal for participation in development of Penstock Inspection Guidelines
Invited Speaker, 1998, Second Yangsan Fault Symposium, Seoul, Korea
Invited Speaker, Association of Bay Area Governments 1997 El Niño Conference
Invited Lecturer, ASCE Landslide Repair Workshop, Oakland CA 1996

EXAMPLE PROJECTS

- Grizzly Powerhouse and Tunnel Project (1991-1993) geologic/geotechnical studies, design work & construction
- Rucker Tunnel and Halsey Tunnel Evaluations (1992, 1993) geologic assessment and mitigation work
- Highway 50 Mill Creek Landslide Evaluation (1996) geotechnical evaluation of landslide that closed highway
- Rock Slope Evaluation, Stabilization, and Instrumentation (1992-1999) geologic/geotechnical studies, design, construction monitoring for over 20 different projects
- Caltrans and Local Agency Bridge Seismic Retrofit Studies (1993-1999) geologic and foundation studies, retrofit foundation design, construction monitoring for over 30 bridges
- Seismic Stability Analyses Critical Facilities Diablo Canyon Nuclear Power Plant (1996-1997) geologic characterization & stability analyses of soil and rock slopes
- Arch Dam Stability Studies (1991-1994) geologic and foundation characterization, stability assessment for 5 arch dams
- Proposed Nuclear Waste Storage Facility 91996-1999) geologic and ground motion studies